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## HUMAN FACTOR PROBLEMS IN ANTI-SUBMARINE WARFARE

Supplementary Note to Technical Report 4

### CROSS-VALIDATION OF SOME CORRELATES OF VIGILANCE PERFORMANCE

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HUMAN FACTOR PROBLEMS IN ANTI-SUBMARINE WARFARE

Supplementary Note to Technical Report 4

CROSS-VALIDATION OF SOME CORRELATES OF VIGILANCE PERFORMANCE

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## SUMMARY

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In an exploratory study of the correlates of vigilance performance a number of significant correlations were found between psychological test scores and measures of vigilance performance. In subsequent studies of vigilance cross-validation data were obtained and several additional tests were administered. The results showed that none of the thirty-five test variables studied consistently predicted performance on auditory and visual vigilance tasks. This negative finding was considered to be a reflection of the task-specificity of individual differences in vigilance performance and made questionable the possibility of selecting through the use of traditional psychological selection techniques the more vigilant performers for practical vigilance tasks. ↙



## CROSS-VALIDATION OF SOME CORRELATES OF VIGILANCE PERFORMANCE

The finding of large individual differences in performance has been practically universal in vigilance research. These differences have been shown (Buckner, Harabedian, and McGrath, 1960) to be reliable both within a single watch period and from one watch period to another. Since individual differences in vigilance performance are both large and reliable, they should be predictable. This report summarizes an effort to develop or discover predictors of vigilance performance.

### Background

Most studies of the correlates of vigilance performance have been concerned with the correlation between measures of general intelligence and criteria of performance on vigilance tasks. Solandt and Partridge (1946), Mackworth (1950), Jenkins (1958), McGrath, Harabedian, and Buckner (1960) and Ware (1960) have all found no significant relationship between measures of general intelligence and vigilance performance. Kappauf and Powe (1959) were the only ones to find such a relationship. They obtained one significant correlation ( $r = .30$ ) out of four that were computed. It seems safe to conclude that one cannot expect to improve vigilance performance by selecting the more intelligent men for such tasks.

At least one temperament variable, introversion-extroversion, has been shown to be correlated with vigilance performance (Bakan, 1957). Bakan's results have been confirmed by Colquhoun (1960), but in each of these studies the relationship between introversion-extroversion and vigilance performance was shown to interact with either task variables or time of day.

McGrath, et al., (1960) took a more general approach to the problem of discovering or developing predictors of vigilance performance. Their purpose was to investigate the relationships between a large number of behavioral measures and criteria of performance on vigilance tasks. The investigation was directed toward ascertaining the types of behavioral measures rather than the specific measurement instruments that might be predictive of vigilance performance.

In this report the investigation by McGrath, et al., (1960) will be called the "standardization study." The purpose of this supplementary report is to present the results of a cross-validation of the findings of the standardization study.

### The Standardization Study

In the standardization study, 54 subjects stood 16 watches on a visual vigilance task and 16 watches on an auditory vigilance task. Several types of performance measures were obtained for each of these tasks.

1. Percentage of signals detected. This was taken as the major criterion of performance. The reliabilities of these measures were .89 for the visual task and .72 for the auditory task.
2. Latency of response. The latency of response score indicated the average amount of time the subject took to respond to those signals he detected. Latencies of false detections were not included in this score and no time constant was included for missed signals. Reliability of latency scores was .70 for the visual task and .68 for the auditory task.
3. Decrement scores. The percentage of detections for the total group declined as a function of time on watch. The amount of decline was different for different subjects. There was an immediate decline in the percentage of signals detected from the pretest to the first part of the watch and a further decline during the watch. Since the two decrements may have reflected two different processes, two different decrement scores were derived:
  - a. The pretest to watch decrement score was the difference between the percentage of signals detected under alerted conditions (combined pretest, posttest scores) and the percentage of signals detected under prolonged watch conditions. The reliability estimates were .26 for the visual task and .77 for the auditory task.
  - b. The within watch decrement score was the difference between the percentage of signals detected during the first quarter hour of watch and the percentage of signals detected during the quarter hour in which performance was at its lowest point for a particular subject. Reliabilities of the within watch decrement scores were .53 for the visual task and .52 for the auditory task.
4. Sleeper versus non-sleeper. The subjects were divided into two groups: those who had been discovered sleeping on at least one watch and those who had not been discovered sleeping on any watch. It turned out that half of the subjects fell in the sleeper group and half in the non-sleeper group.

Seventeen different psychological tests yielding 30 separate scores were tried out as possible predictors of vigilance performance. These tests were chosen on the basis of tentative hypotheses about the aptitude, temperament, and motivational variables that seemed to be important in

the performance of vigilance tasks. The 17 tests were:

1. Navy General Classification Test
2. Arithmetic Aptitude
3. Radio Aptitude
4. Sonar Aptitude
5. Mechanical Aptitude
6. Clerical Aptitude
7. Electronic Technician Selection Test
8. Visual Speed and Accuracy
9. Attention Test
10. Memory Span
11. Circle Reasoning
12. Brick Uses
13. The Guilford-Zimmerman Temperament Survey
14. Manifest Anxiety Scale
15. The Willingness to Guess Test
16. The Behavior Interpretation Inventory
17. The O-Dotting Test

Complete descriptions of these tests and the sub-scores derived from some of them and statements of the tentative hypotheses are in the original research report of the standardization study (McGrath, et al., 1960).

Correlational analyses indicated a number of significant correlations between psychological test scores and various criteria of vigilance performance, but the correlations were generally low in magnitude and many of them undoubtedly occurred by chance. Obviously, they could not be interpreted with any confidence until cross-validation data were obtained.

#### THE CROSS-VALIDATION STUDIES

The most promising of the predictor tests were administered to subjects taking part in two subsequent studies of vigilance performance. Test scores and criterion data were obtained for two groups of Navy personnel (N = 18 and N = 19) taking part in a study of the effect of irrelevant environmental stimulation on vigilance performance (McGrath, 1960). Similar data were obtained for 27 Navy personnel taking part in a study of dual-mode monitoring (Buckner and McGrath, 1961). In each of these studies the same vigilance tasks were used as were used in the standardization study.

Since there were few instances of sleeping on watch during the cross-validation studies, correlations with this criterion could not be tested. There were no significant correlations with latency of response in the standardization study, so this criterion also was not used in the cross-validation studies.

Additional tests were administered to the cross-validation samples. These were:

1. Visual Pursuit: visually tracing intertwining lines and matching the endings of separate lines with their beginnings.
2. Coding: decoding a narrative passage using a simple letter-numeral code.
3. Counting: counting the numbers of specified letters appearing in a narrative passage.
4. Proofing: detecting n's and c's among typewritten lines of m's and o's.
5. Audio-Visual Checking: comparing series of written digits with an auditory series of digits and detecting discrepancies between the two. This was a 20-minute version of the vigilance task used by Kappauf and Powe (1959).

## RESULTS

The results are presented in Table I. They indicate that none of the original significant correlations consistently appeared in the cross-validation samples. Three of the tests that correlated significantly with performance criteria in the standardization sample correlated significantly with the same criteria in the cross-validation samples. However, in two cases, that of the Visual Speed and Accuracy test and the Clerical Aptitude test, the cross-validation validities were reversed in sign compared with the standardization validities. Only the O-Dotting recovery score yielded a significant correlation on cross-validation, but this was not confirmed on the second cross-validation attempt. None of the tests correlated significantly with any of the criteria of vigilance performance.

## DISCUSSION

Thirty-five different test variables were studied in the research summarized in this report, and it was found that scores on none of them consistently correlated with measures of performance on the vigilance task used. This result may reflect the task specificity of individual differences in vigilance performance as demonstrated by Buckner, et al., (1960) and confirmed by Baker (1960). That is, there is a high correlation between individual performances on the same task, but a low correlation between individual performances on different tasks. If differences between individual performances are specific to the characteristics of the vigilance task, then it may not be possible to predict individual performances consistently from measures of the general psychological characteristics of the performers.

Further research is needed in which the same subjects perform a variety of vigilance tasks. Data from such research may be used to identify the factors that produce the task-specificity of individual differences in vigilance performance.

Table I  
Correlations between Test Scores and Performance Measures  
Obtained in a Standardization and Two Cross-Validation Samples

TASK	CRITERION	TEST	STANDARDIZATION (N = 50-54)	CROSS-VALIDATION STUDIES	
				#1 N = 18, 19	#2 N = 27
V I S U A L	Percentage Detections	ETST	.32*	-	-.35
		O-Dotting (recovery)	-.29*	-.05	-.26
		Mechanical Aptitude	.29*	-	-.36
	Pretest-to- watch decre- ment	Mechanical Aptitude	-.31*	-	.12
	Within-watch decrement	Visual Speed & Accuracy (speed score)	-.31*	.48*	.00
A U D I T O R Y	Percentage Detections	MMPI "K" Scale	-.49**	.26	-
		Sonar Aptitude	.34*	-	.00
		O-Dotting (recovery)	-.29*	-.39	.05
	Pretest-to- watch decre- ment	O-Dotting (recovery)	.34*	.52*	.10
	Within-watch decrement	Attention Test (total)	-.47**	-	.09
		Visual Speed & Accuracy (errors)	.39**	.12	.03
		Clerical Aptitude	-.33*	-	.38*
		Attention Test (errors)	.31*	-	.04

\* Significant at .05 level.

\*\* Significant at .01 level.

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